MECHANICAL ENGINEERING
UNIVERSITY of WASHINGTON

Autumn 2012

The MEssenger

Undergraduate Research: The *Student* Perspective

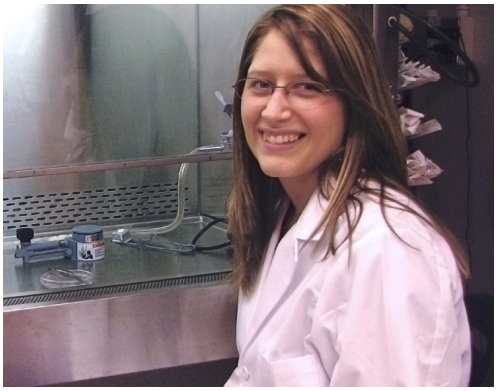
In the Department of Mechanical Engineering (ME), our drive to discover and innovate leads to many opportunities for undergraduate students to participate in research, design, and development. Rhiannon Howard, Wes Tooley, and Ariel Medina are three ME students who worked in Professor Nate Sniadecki's Cell Biomechanics Lab as undergraduates. Sniadecki's lab studies how cells are influenced by mechanical interactions at the micro- and nano-scale.

Rhiannon, a ME senior, joined Sniadecki's lab group after he came to give a presentation on endothelial cell (the cells that make up the inner lining of the arteries) mechanobiology to her Biomechanics seminar. During the seminar, Rhiannon asked Sniadecki about the relationship between how fast blood flows and the forces between the endothelial cells. Sniadecki invited her to join the research group in his lab to learn more.

Rhiannon now has her own research project, working to discover the relationship between shear stresses along the arterial wall and the permeability of the endothelial cell layer. Rhiannon's research will provide insight into the formation of atherosclerosis, a disease in which blockages form in the arteries, hardening them and leading to heart attacks and strokes.

In the summer of 2012, Rhiannon was awarded a NASA Summer Undergraduate Research Grant to continue her work. "I am really enjoying my experience in the lab," she says. "I found it a little intimidating at first, with so many new things to learn and potential mistakes that could really set the research back, much like starting a new job. But as I spent more time in the lab I have become more comfortable with the processes."

Wes Tooley, who worked in Sniadecki's lab from July 2009 until he graduated in March 2011, began by investigating a surface cracking issue that the lab was experiencing during one of their soft lithography casting processes, and soon realized the practical use of his coursework. "My research introduced me to a new way of thinking," he said. "It was reassuring to see that everything I was learning in class is actually put to use. We're trying to figure



Rhiannon Howard in Professor Nate Sniadecki's Cell Biomechanics Lab.

something out, and we have no idea how to do it. We have to figure out what tools are available to us and what our plan of action is. When we get one result, we have to find out what our next step is. It's very open-ended, with many routes to take."

Ariel Medina, a sophomore who plans to major in mechanical engineering or bioengineering, also says that the fact that no one knows the answers to the questions that are being asked is one of her favorite aspects of research. In the lab, Ariel develops methods to place nanowires into micro-posts, used as cell force transducers, without causing the micro-posts to collapse. "Doing research is a great way to

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Chair's CORNER

Per Reinhall, ME professor and chair

In the Department of Mechanical Engineering, we aim to ensure that our students graduate with hands-on engineering experience. Today, mechanical engineering goes beyond a technical degree. Our students lead and fully participate in projects that help address real-world problems.

I am proud of the many ways faculty and students embrace the practical aspects of mechanical engineering, through undergraduate research, internships and co-ops, and industry-sponsored capstone design projects. This exposure to research early in their academic careers enhances their prospects for future employment and shapes the path they will pursue as engineers (see cover story). Internships and co-ops offer students experience in industry and allow them to build their professional skills. Lastly, our partnerships with industry extend to student capstone design projects, facilitating students' exposure to economics, innovation, prototyping and engineering fundamentals (pages 4 and 5).

This year, ME again increased undergraduate enrollment, and we plan to strategically expand our capacity to admit more students in the years to come. Our goal in expanding enrollment is to meet the need from within the community while preserving the quality of our educational experience. Adding more students requires more faculty and in turn more graduate students to serve as teaching/research assistants and mentors. Funding for faculty and graduate students will therefore become an increasing priority for ME. We hope to translate the financial success of our undergraduate scholarship program (page 7) to address these needs, making significant strides in admitting and graduating more mechanical engineers.

In the near future, we will formalize independent projects that have been occurring for years in the fields of medicine and health care. Over 15 ME faculty currently work on health related research projects in partnerships with clinicians and health care professionals. ME currently leads the effort to establish the Engineering Innovation in Medicine Initiative, building on partnerships between all UW Engineering departments, UW Medicine, the Veterans Affairs Hospital, and Seattle Children's Hospital.

As always, please feel free to contact me to share your thoughts, questions or concerns. I welcome your advice and feedback on how to move our department forward. I also invite you to visit our department and tour our labs and student projects. ▪

ME Leadership Seminar Series 2012

ME wishes to thank the following alumni and friends for participating in our leadership seminar series:

Chris Allard, BSME '80
Senior Project Manager, Kearl Project
ExxonMobile Development Company

John T. Major, BSME '83, MBA 2000
Former VP, Global Operations, Radisys, Inc
Founder and Managing Partner, Summit Core Strategies, LLC

Dave Melin, BSME '79
Serial Entrepreneur

Thomas Nault
Entrepreneur, Turnaround Specialist, Advisor

Bill Rosen, BSME '57
Manager, Alaskan Copper Works
Chairman/CEO, Alaskan Copper Companies, Inc.

Don Rosen, BSME '58
Engineering Manager, Alaskan Copper Works

Dan Sanders, BSME '85, PhD '08
Senior Technical Fellow, Director of Manufacturing Science
The Boeing Company, Boeing Research & Technology

Fred Silverstein, M.D.
Retired Professor of Medicine UW School of Medicine
Retired General Partner of Frazier Healthcare
Founder of Lucent Medical Systems

Contact April Johnson to learn more about the ME Leadership Seminar Series by phone at 206-543-8779 or e-mail aprijohn@uw.edu.

ME Welcomes New Faculty

Maria de Gador Canton joins ME from the UW Radiology Department, where she was a Senior Fellow in the Vascular Imaging Laboratory. She earned her PhD in Mechanical Engineering at the University of California, San Diego, where she was a postdoctoral scholar until joining the UW. Professor Canton's research focuses on the interaction between the behavior of biological fluids and pathological processes. In particular, she is interested in the role that mechanical stresses play in the etiology of diseases in the circulatory system. Over the years she has developed expertise in experimental and computational techniques to characterize blood flow and identify flow conditions associated with cardiovascular diseases such as intracranial aneurysms, carotid atherosclerosis and abdominal aortic aneurysms, and has established multidisciplinary collaborations with neurosurgeons, radiologists, vascular surgeons, and medical device companies. Canton looks forward to consolidating a program where medical imaging and mathematical modeling tools are used together to advance medical diagnostic processes and enable more effective treatment. Her honors include a fellowship from the UW School of Medicine Cardiovascular Research Training Program and a R.B. Woolley Jr. Graduate Leadership Fellowship from UCSD's Jacobs School of Engineering.

Sooyuen Kim earned her Ph.D. degree in Materials Science & Engineering at UW, where she was a research associate in ME. Her research focuses on chromic materials and energy harvesting devices. Her work enables novel technologies in energy harvesting windows and energy saving windows for building, aircraft and automobile applications. Her recent research project includes the design of electrochromic materials and color-switchable dye sensitizers, the development of composite electrolytes, device fabrication and characterization. She is also interested in smart materials for applications in the construction, transport and medical areas. Professor Kim looks forward to collaborating with researchers across the College of Engineering.

Awards, Honors and Events

Professor Alberto Aliseda was promoted to Associate Professor with tenure.

Graduate student **Alicia Clark** was awarded the NSF Graduate Fellowship.

Professor Peter Dahl was elected vice president of the Acoustical Society of America.

Professor Emeritus Colin Daly and staff engineer **Bill Kuykendall** aided in the design and construction of the ATLAS detector at CERN, thus playing an important role in the discovery of the Higgs boson.

Professor Santosh Devasia has been elected as Fellow of ASME.

Professor Brian Fabien was awarded the NSF Outstanding Incoming Faculty Advisor Award.

Staff members **Wanwisa Kisalang** and **David Melville** and graduate student **Renuka Prabhakar** were awarded the College of Engineering Community of Innovators Award.

Professor Vipin Kumar became a UW Presidential Entrepreneurial Faculty Fellow, and received the 2012 ASME Thomas A. Edison Patent Award.

Professor Ramulu Mamidala won the 2012 UW Distinguished Contributions to Lifelong Learning Award.

Professor Brian Polagye became the Co-Director of the Northwest National Marine Renewable Energy Center, and is the PI on a $1.25M NSF Sustainable Energy Pathways grant.

Professor Jonathan Posner became a STARS Professor.

Professor Jim Riley was elected into the Washington State Academy of Sciences. He was also appointed Chair of the Division of Fluid Dynamics of the American Physical Society.

Professor Katherine Steele was awarded an NSF Early Career Award.

Minoru Taya Awarded Nabtesco Endowed Chair

From left: Dr. Kazuyuki Matsumoto, Chairman of Nabtesco, Professor Minoru Taya and Associate Dean Mari Ostendorf.

In April, Professor Minoru Taya was appointed the first Nabtesco Endowed Chair Professor of Mechanical Engineering, which was established in 2011 in support of outstanding ME faculty in the areas of active materials and actuator technology. The funds to establish the endowed chair were given to the Department of Mechanical Engineering by the Nabtesco Corporation, a Tokyo-based company that uses motion control as the core of its manufacturing activities in a wide range of fields. Founded in 2003, Nabtesco's manufacturing activities extend to trains, marine vessels, automobiles, industrial robots and automatic doors. By endowing a chair in Mechanical Engineering, Nabtesco hopes to advance research and teaching in the field of actuator technology.

In addition to the endowed chair, Nabtesco currently funds Taya's work on the design of nanorobotics with ferromagnetic shape memory alloy (FSMA) as a key building block active material. FSMA is expected to meet the tough requirements of airborne acuators, which must be lighter, faster, stronger and more durable than other actuators. If successfully designed, processed and assembled, nanorobotics using FSMA could move beyond aviation to open new biomedical diagnosis and treatment possibilities.

Taya's other research areas include shape memory alloy based joining technology, which may be applied to assembly of Boeing airplanes, wind turbine components, and new dental implants. He also works on green-energy technology, developing an electrochromic window which can be applied to zero energy buildings. ▪

WOOF Team Wins 3D4D Challenge

In October, a team of ME undergraduate students claimed top prize in the first 3D4D Challenge. This international contest challenges participants to use 3-D printing for social benefit in the developing world. Brandon Bowman, Bethany Weeks and Matt Rogge won $100,000 to form a nonprofit that will work with partners in Oaxaca, Mexico, to build machines that can transform plastic waste into composting toilets and pieces for rainwater harvesting systems.

The winning proposal they presented uses giant 3-D printers to create composting latrines that are lightweight and require less energy to manufacture than concrete toilets. The printers would also make rainwater catchment components that are specifically designed to fit to rain barrels, unlike current systems where frequent leaks and failures are caused by joining available and inadequate plumbing parts.

Judges were impressed by research the students conducted to prove their concept. In July, the students printed a boat from shredded, recycled milk jugs and entered it in a Seattle race. This was a pilot test for their custom-built giant printer and proved that they could create functional objects from recycled plastic.

The students are all members of the Washington Open Object Fabricators (WOOF) a 3-D printing student club formed in the last year that already exceeds 50 members. Club members will be invited to help test concepts for the new nonprofit, while continuing to learn and experiment with 3-D printing. ▪

Original story by Hannah Hickey.

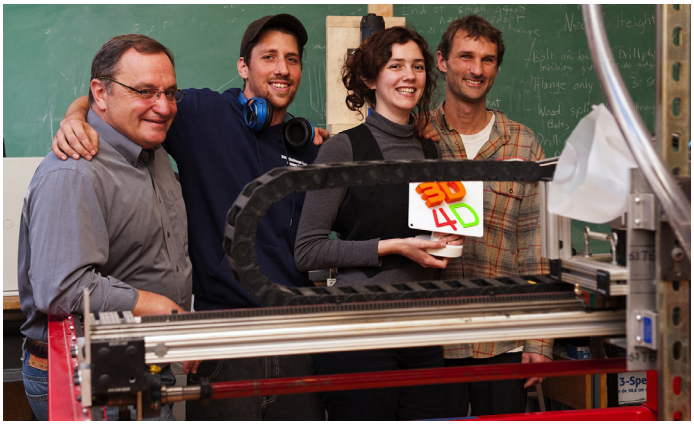


Photo by Alison Deng

From left: Prof. Duane Storti, a WOOF team adviser, and team members Brandon Bowman, Bethany Weeks and Matt Rogge with their trophy. In the foreground is Big Red, a giant 3-D printer that can turn plastic garbage into new objects.

Scholarships: The Impact of Alumni Investment

"When I first received my acceptance letter to the UW I was immediately filled with a mix of both excitement and anxiety; excitement at the great opportunity and privilege placed before me, but anxiety about the immense price tag that came with it."
-Jeremy Ridge, BSME 2013

Jeremy represents the many ME undergraduate students who directly bear the financial burden of tuition, fees, books, and other educational expenses. Fortunately, through the generosity of alumni, friends, foundations, and companies, the ME department annually awards scholarships to support undergraduates like Jeremy.

Jeremy received the Henry T. Schatz and Carl Hansen Scholarships during his junior year and currently is a Grossman Scholar. The scholarship support enabled Jeremy to end his 40-hour per week job to actively focus on his academics and engineering opportunities outside of the classroom. His summers brought full-time research opportunities in two labs. He participated in the building of telesurgical robotic devices in the BioRobotics Lab and worked on early tooth decay detection using a flexible endoscope in the Human Photonics Lab. These experiences broadened Jeremy's understanding and application of ME theories and concepts, and exposed him to many possibilities for his future career.

In addition to undergraduate scholarships, fellowships support graduate students pursuing their masters or Ph.D. degrees. Graduate students play a critical role in the growth of the department. Through their research and teaching experiences, graduate students enhance the quality of the undergraduate student experience by serving as mentors, tutors, and team leaders on capstone projects. Quality faculty members are also drawn by the caliber of the graduate students who participate in their research projects. Therefore, graduate student enrollment and support enables ME to increase enrollment to undergraduates, who in turn receive an excellent educational experience. This is a virtuous cycle in higher education, where each iteration can increase the academic standing of the department.

This academic year, the ME department received more applications for scholarship and fellowship support than could be met. As the cost of education continues to rise, ME remains committed to expanding our scholarship and fellowship support to meet the monetary needs of students demonstrating academic merit and/or financial need. Our objective to deliver excellence in mechanical engineering education rests on attracting outstanding faculty, graduate students, and undergraduates.

On behalf of the department, thank you to our alumni and friends who have supported students like Jeremy through their contributions to the ME scholarship and fellowship funds, as well as establishing named endowments. Your efforts directly enable exceptional students like Jeremy to pursue their dreams and change the world through their efforts. ▪

Scholars at the 2012 ME Scholarship & Fellowship Luncheon.

ME Celebrates *Diamond Award* Winners

We are very proud that two ME alums, **Paul Anderson** (top), BSME '67 and **Professor Emeritus Albert Kobayashi**, MSME '52, will be among the five 2013 College of Engineering Diamond Award receipients. Anderson, the former CEO and Board Chairman of Duke Energy, will receive the award for Distinguished Achievement in Industry. Kobayashi, a Professor Emeritus in the Department of Mechanical Engineering at UW, will receive the award for Distinguished Achievement in Academia.

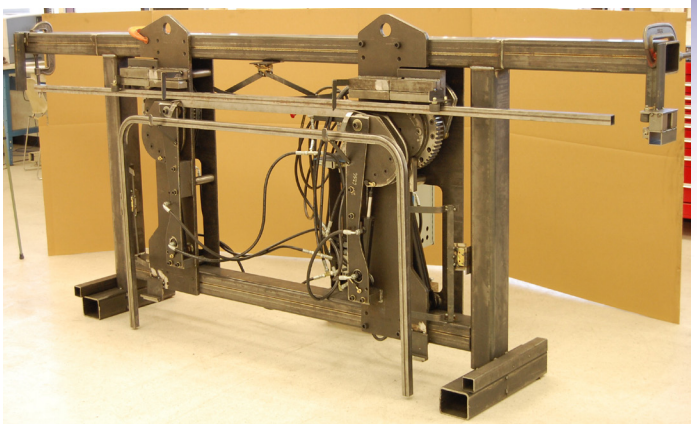
Industry Sponsored Capstone Design Projects

Capstone design projects are the hallmark of an engineering student's education at UW. ME seniors must complete a capstone project, in which they develop a complete design cycle beginning with the definition of an interesting, real-world problem and often resulting in prototype fabrication and testing. Industry sponsored capstone design projects benefit both the students and the company: students are able to access company resources and meet mentors from industry, and the company is able to get key questions answered and recruit talented new engineers.

A Genie lift ready to be shipped. Students attached acceleormeters to the lift to characterize vibrations and recommended ways to reduce the damage to the lift during transport.

Every spring, Professor Vipin Kumar teaches a section of ME 495: Capstone Design for ME seniors. He offers one or more projects sponsored by the local industry in almost every offering of this class. These projects are often carried out over two quarters. Typically, Kumar seeks projects that are on the back-burner: projects that are of interest to the company, but are not on its critical path. This is to protect the students from the day-to-day pressures of the company. As Kumar says, "it is a real win-win situation"for both the student and the company.

Each project has a mentor from the company. The mentor is usually a senior person who provides information and guidance that the student team needs to carry out the project. Most often, the students get access to the company resources for materials and fabrication, and perform a part of the project at the company. "Students love to work on a 'real' project, with a client interested in the outcome of their efforts," says Kumar. On several occasions, students have been hired by the sponsoring company after they graduate.

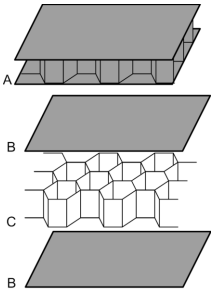


A prototype right-angle railing tube bending machine designed for the Genie GS-1930 MiniScissor Lift.

Recently, MicroGreen, Inc., an Arlington-based company devoted to the commercialization of solid-state microcellular expansion technology, has sponsored many projects from Kumar's ME 495 class. These projects include the design of lightweight sandwich panels for load-bearing applications, design of a method to join rolls of gas-saturated polymer film, and the design of an apparatus for in-situ foaming of a polymer film.

Other industry sponsors of capstone projects include Genie Industries, a Redmond-based company that designs and manufactures lifting equipment. Projects sponsored by Genie include: a project to reduce the damage to lifts caused by vibration during transport, in which students attached accelerometers at various places on a lift to characterize the extent of vibration during transport and developed recommendations to reduce the damage to the lift during transit, and a project to design a steel tube bending machine for a lift platform railing.

ME thanks all of the past and present industry sponsors of capstone design projects. If you are interested in sponsoring a capstone design project, please contact April Johnson at (206) 543-8779 or e-mail aprijohn@uw.edu. ▪



Design of load-bearing panels from flat microcellular PET sheet. Prototype sandwich panel schematic (L) and before (M) and after (R) testing (Sponsor: MicroGREEN Inc., 2012).

Capstone Projects Within Formula SAE & EcoCAR2

Photo by Bradley Freeman

Formula SAE team members in Hockenheim, Germany.

The ME department's Formula SAE team had an outstanding year last year. In the summer, they competed in SAE events in Lincoln, Nebraska and Hockenheim, Germany. In Lincoln, the team placed 4th overall and 1st in the prestigious design competition. In Germany, which is widely known as the most competitive of the twelve FSAE competitions and was the first international event the team has entered, they finished 14th overall out of 77 teams.

The FSAE team is comprised of nearly 50 students, divided into groups to focus on different aspects of the car's design, manufacturing and testing. This year, the team plans to focus on aerodynamics and fuel economy in order to make the car lighter and more powerful. Capstone design projects will be an integral aspect of this goal. Last year, one capstone design group built a modified rear cradle to hold the electric drive train of the car. This year's capstone projects include building carbon fiber wheel shells, a turbocharger to create more power, and a prototype system that can be used for future cars. The FSAE team is also excited to begin developing an electric car in addition to their combustion car, and plan to compete with both in Nebraska and Germany.

The EcoCAR2 team is another student team that provides capstone design project opportunities. By 2025, new federal regulations stipulate that automakers will need to nearly double the average gas mileage of all new cars and trucks they sell to obtain an average of 54.5 mpg. The EcoCAR2 team is getting a head start on this effort. The team has begun its second year of a three-year competition, sponsored by the U.S. Department of Energy and General Motors, to develop a hybrid car that they estimate will average 96 miles per gallon. The car will have two motors - a diesel to power the front wheels, and an electric to power the back. The car will use its rear-wheel electric motor for the first 45 miles before switching over to the front-wheel biodiesel motor.

There are many opportunities for capstone design projects within the EcoCAR2 team. This year, capstone design projects within the 30-member team include fabricating an engine mount, focusing on diesel emissions control, and the assembly and testing of the battery pack of the car. These projects not only fill curriculum requirements for ME undergraduates, but are also crucial components of the EcoCAR2. ▪

EcoCAR2 team members.

MECHANICAL ENGINEERING
UNIVERSITY of WASHINGTON

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The MEssenger

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Undergraduate Research

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learn from your mistakes because they aren't spelled out for you in a book or told to you by a teacher, rather the mistakes are there for you to solve and the only way to solve them is by working hard for the answers," she says. "I enjoy the process of learning through research and through my mistakes in my research."

Wes Tooley working in Prof. Sniadecki's lab.

For undergraduate student researchers, one of the biggest benefits of working in a lab can be the opportunity to meet mentors. "I have learned that working with graduate students is invaluable, since they have already been through many of the things I hope to work through," says Rhiannon. "It is also valuable that I already have a mentor who helps me through the process of applying to graduate school and most importantly, inspires me to do better, try harder and push farther to accomplish things I may not have thought I could." Wes didn't plan to go to graduate school. However, graduate students in the lab encouraged him. "Doing my own research as an undergrad taught me what a graduate student does, and it became much more feasible," he says. Wes began his first year as a graduate student in ME this Autumn Quarter.

Prof. Sniadecki (third from left) and his Biomechanics Lab group of graduate and undergraduate students at Golden Gardens in summer 2012.

For these students, conducting research was essential to shaping their interests and goals. It provided a hands-on approach to design, discovery, problem-solving, and innovation. Says Ariel, "Conducting research here at the UW is something totally different from anything else I've done to this point and it's been one of the best things I've participated in. It is how I know that engineering is the right direction for me." ▪